THE HUMAN BODY: From Cells to Body Systems

by Genius Jigisha

© 2026 Genius Jigisha
All rights reserved.

CONTENTS

Chapter 1 – Introduction to the Human Body

Chapter 2 – Integumentary System

Chapter 3 – Skeletal System

Chapter 4 – Muscular System

Chapter 5 – Nervous System

Chapter 6 – Digestive System

Chapter 7 – Cardiovascular System

Chapter 8 – Lymphatic System

Chapter 9 – Respiratory System

Chapter 10 – Urinary System

OUR BODY!

1.Introduction:-

Our body is made up of CELLS.
CELL-A cell is the fundamental structural and functional unit of all living organisms, capable of independent life, growth, and reproduction.It has two types:eukaryotes (with a nucleus) and prokaryotes (without).
Let's see the parts of animal cell:

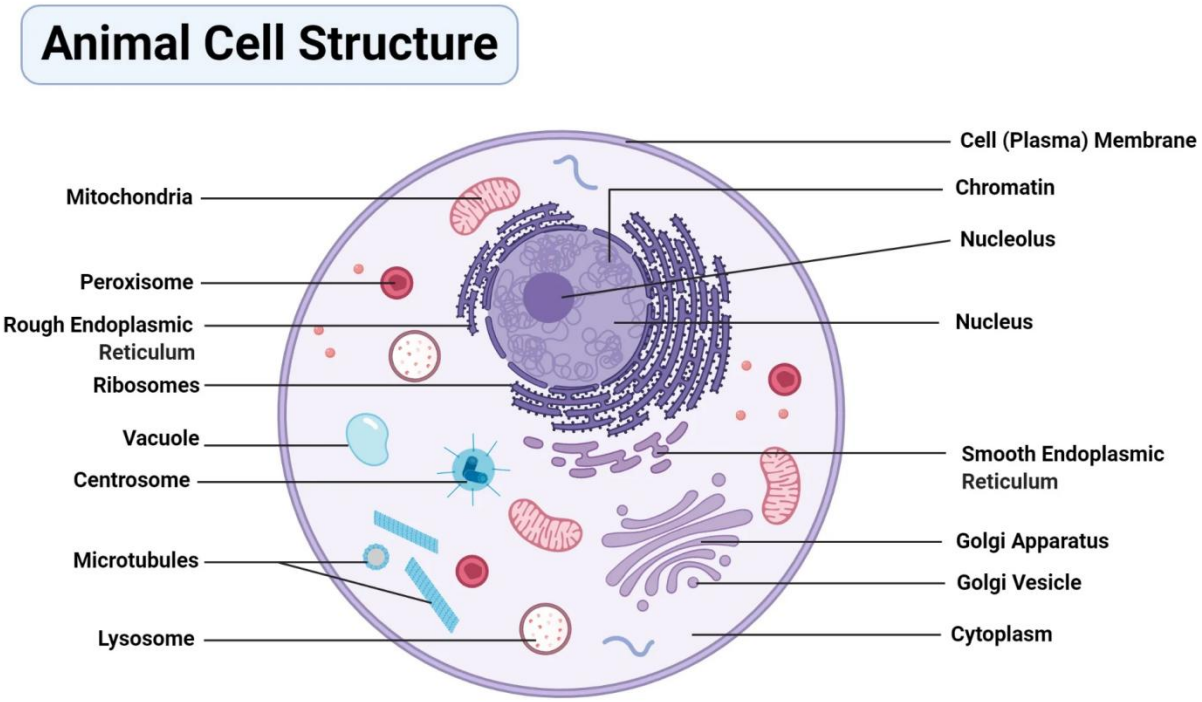


Figure: Animal Cell Structure, Image Copyright © Sagar Aryal, www.microbenotes.com

Animal Cell – Complete Functional Flow (Exam-Level) :

Nucleus

Does: Controls all activities, stores DNA

- Makes: Instructions (mRNA from DNA)
- Goes to: Ribosome
- Helps: Decides what proteins/lipids the cell needs

Nucleolus

Does: Makes ribosomal components

Makes: rRNA + ribosome subunits

Goes to: Cytoplasm → becomes ribosomes

Helps: Protein-making machinery

Ribosome

Does: Protein synthesis

Makes: Proteins

Goes to:
Free → stay in cytoplasm
Bound → go to RER
Helps: Enzymes, structure, hormones

Rough Endoplasmic Reticulum

- Does: Processes proteins
- Makes: Modified proteins
- Goes to: Golgi apparatus
- Helps: Protein transport & folding

Smooth Endoplasmic Reticulum

- Does: Lipid synthesis + detox
- Makes: Lipids, phospholipids
- Goes to: Golgi / membranes
- Helps: Membrane formation, detoxification

Golgi apparatus

- Does: Modifies, sorts, packages
- Makes: Final proteins/lipids (functional form)
- Goes to: Vesicles → membrane / lysosome / secretion
- Helps: Proper delivery system

Plasma

Does: Transport

Carries: Proteins/lipids

Goes to: Target location
Helps: Movement inside cell

Chromatin

- Does: Genetic material
- Makes: Codes for proteins
- Helps: Heredity + cell function control

Mitochondrion

- Does: Respiration
- Makes: ATP (energy)
- Goes to: Whole cell
- Helps: Powers all activities

Cytoplasm

- Does: Medium for reactions
- Contains: Organelles
- Helps: All processes happen here

Vacuole

- Does: Storage
- Stores: Water, food, waste
- Helps: Balance inside cell

Microfilament

- Does: Support + movement
- Helps: Shape, cell movement

Centrosome

Does: Organizes spindle fibers

Helps: Cell division

These cells make tissues,and then tissues make organs,organs make body systems and skin.

Different Types Of Body Systems:

Integumentary System: Composed of skin, hair, and nails; it provides protection, acts as a barrier, and regulates temperature.

Skeletal System: Composed of bones, cartilage, and ligaments; it provides structure, support, and protection for internal organs.

Muscular System: Composed of skeletal, smooth, and cardiac muscles; it allows for voluntary and involuntary movement.

Nervous System: Composed of the brain, spinal cord, and nerves; it coordinates body functions and processes sensory information.

Digestive System: Composed of the stomach, intestines, liver, and pancreas; it breaks down food and absorbs nutrients.

Cardiovascular/Circulatory System: Composed of the heart, blood vessels, and blood; it transports oxygen, nutrients, and waste throughout the body.

Lymphatic/Immune System: Composed of lymph nodes, vessels, and cells; it provides immune defense and returns fluids to the blood.

Respiratory System: Composed of the lungs, trachea, and nasal passages; it exchanges oxygen and carbon dioxide between the body and air.

Urinary/Excretory System: Composed of kidneys, bladder, and urethra; it removes waste from the blood and regulates fluid balance.

Endocrine System: Composed of glands (e.g., thyroid, pituitary, pancreas); it produces hormones that regulate metabolism, growth, and reproduction.

Reproductive System: Composed of sex-specific organs; it produces gametes and hormones to create offspring.

2.Integumentary System:-

Introduction

The integumentary system is the outermost covering of the human body. It forms a protective barrier between the internal organs and the external environment. This system not only protects the body from injury and harmful microorganisms but also plays an important role in maintaining internal balance, known as homeostasis.

Components of the Integumentary System

Skin

The skin is the largest organ of the body. It covers the entire body and acts as the first line of defense against physical damage, germs, and harmful substances. It also helps in regulating body temperature and preventing water loss.

Hair

Hair grows from hair follicles present in the skin. It helps in protecting the body, especially sensitive areas like the scalp (protects from sunlight) and eyes (eyelashes prevent dust from entering). Hair also helps in sensing light touch.

Nails

Nails are made of a tough protein called keratin. They protect the tips of fingers and toes and help in performing precise movements like picking up small objects.

Sweat Glands

Sweat glands produce sweat, which is mainly composed of water and small amounts of salts and waste products. When sweat evaporates from the skin surface, it helps to cool down the body, thus maintaining temperature.

Sebaceous (Oil) Glands

These glands produce an oily substance called sebum. Sebum keeps the skin soft, prevents it from drying out, and provides a waterproof layer. It also offers some protection against bacteria.

Structure of the Skin

The skin is made up of three main layers, each with specific functions:

Epidermis (Outer Layer)

This is the avascular, top layer composed mainly of **keratinocytes** (structural cells) that constantly renew, moving from the base to the surface in roughly 30 days. It contains specialized cells for immunity (Langerhans cells) and pigmentation (melanocytes).

- **Stratum Corneum:** The surface layer of dead, keratinized cells that prevents water loss and entry of pathogens.
- **Stratum Basale:** The deepest layer containing stem cells that produce new keratinocytes.

Dermis (Middle Layer)

The dermis lies beneath the epidermis and is thicker. It contains:

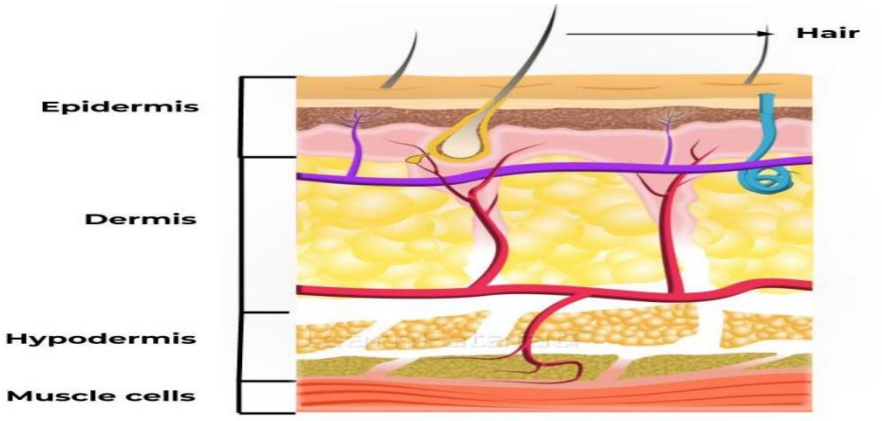
- Blood vessels (supply nutrients and oxygen)

    - Nerve endings (for sensation)
    - Hair follicles
    - Sweat and oil glands
- Collagen and Elastin: Proteins that provide structural integrity and elasticity.
- Adnexal Structures: Hair follicles, sebaceous (oil) glands, and sweat glands.
- Vessels and Nerves: Blood vessels, lymph vessels, and sensory nerves.
- Layers: The papillary dermis (upper, loose layer) and reticular dermis (lower, thick layer).

This layer provides strength, flexibility, and elasticity to the skin.

Hypodermis (Inner Layer)

The hypodermis is the deepest layer, made up of fat and connective tissue. It acts as a shock absorber, protecting internal organs. It also stores energy and helps in insulating the body to maintain temperature.



Functions of the Integumentary System

1. Protection

The integumentary system protects the body from physical injury, harmful microorganisms, and UV radiation. It acts as the body's first line of defense.

2. Temperature Regulation

The body maintains its temperature through sweating and blood flow. When the body gets too hot, sweat is produced and evaporates, cooling the body. Blood vessels also expand or contract to control heat loss.

3. Sensation

The skin contains nerve endings that help us detect touch, pressure, pain, heat, and cold. This allows the body to respond quickly to environmental changes.

4. Excretion

Sweat glands remove small amounts of waste products such as salts and urea from the body.

5. Vitamin D Production

When the skin is exposed to sunlight, it helps in the production of Vitamin D, which is essential for strong bones and calcium absorption.

5. Importance of the Integumentary System

The integumentary system is essential for survival. It:

- Protects the body from external harm

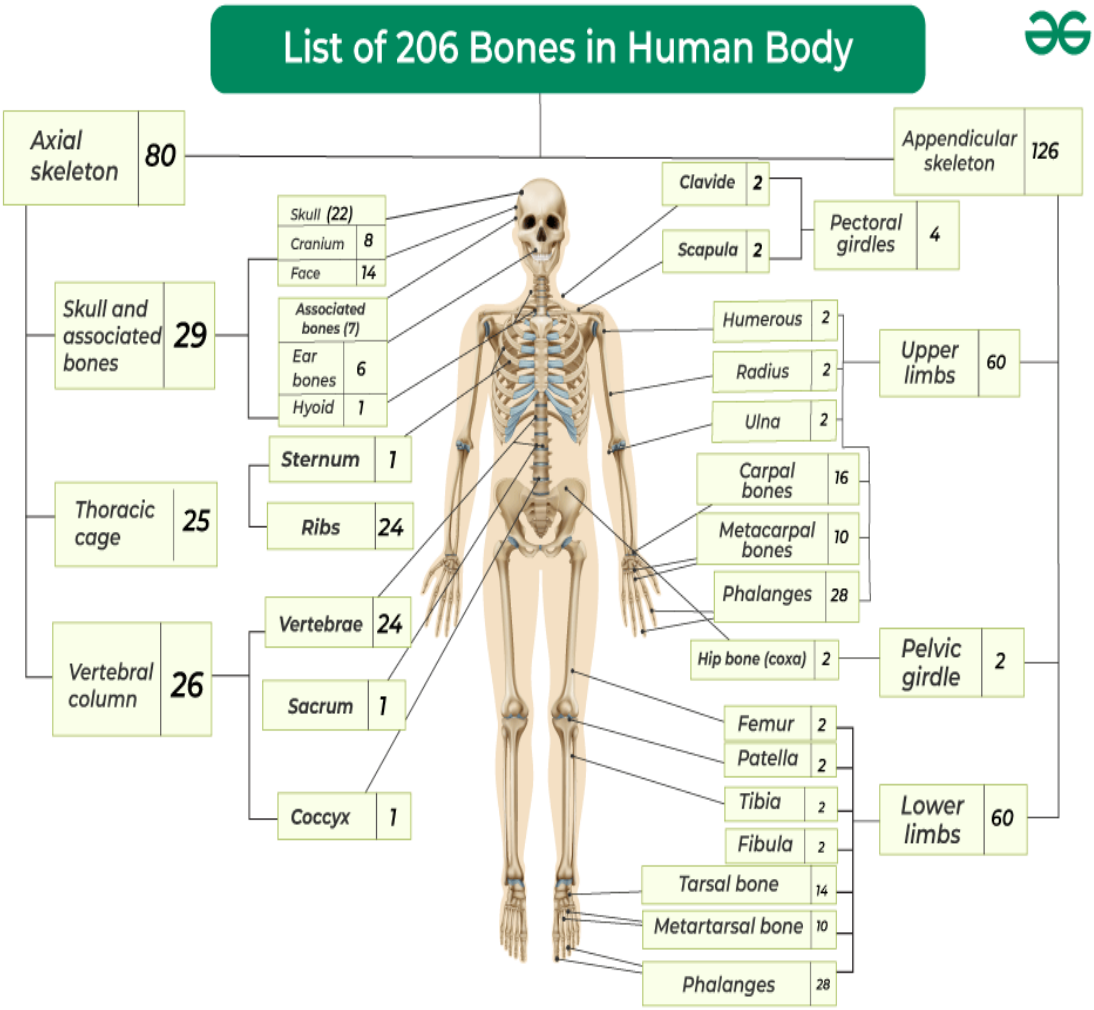
- Maintains internal balance (homeostasis)
- Supports other body systems

Without this system, the body would be highly vulnerable to infections, dehydration, and temperature imbalance.

3. Skeleton System:-

The skeletal system is the body's internal framework, composed of 206 bones (in adults), cartilage, ligaments, and tendons that provide structural support, protection for organs, and enable movement. It stores essential minerals like calcium, produces blood cells in marrow, and is divided into axial and appendicular skeletons.

Bones with their functions and names:



1. Axial Skeleton (Head and Torso)

- Cranium (Skull): Protects the brain; located at the top of the body.
- Mandible (Jawbone): Enables chewing and facial movement; located in the lower jaw.

- Vertebrae (Spinal Column): Protects the spinal cord and supports the back, including cervical (neck), thoracic (chest), and lumbar (lower back) vertebrae.
- Sacrum/Coccyx (Tailbone): Provides structural support at the base of the spine.
- Ribs (Ribcage): Protects the heart and lungs; 12 pairs in the thoracic cage.
- Sternum (Breastbone): Protects the heart and links the ribs at the chest center.

2. Appendicular Skeleton (Shoulder/Arms/Hands)

- Clavicle (Collarbone): Connects the arm to the trunk, acting as a strut.
- Scapula (Shoulder Blade): Attaches the humerus to the clavicle, allowing shoulder movement.
- Humerus (Upper Arm): Main bone in the upper arm, enabling lifting and pushing.
- Radius/Ulna (Forearm): Allows rotation and movement of the forearm/elbow.
- Carpals (Wrist): Provides flexibility to the wrist.
- Metacarpals (Hand): Form the palm structure.
- Phalanges (Fingers/Toes): Enable gripping and fine motor skills.

3. Appendicular Skeleton (Pelvis/Legs/Feet)

- Pelvis (Hip Bone): Supports the upper body and protects lower organs.
- Femur (Thigh Bone): Strongest/longest bone, enabling mobility and supporting weight.
- Patella (Kneecap): Protects the knee joint and strengthens the tendon.
- Tibia (Shin Bone): Main weight-bearing bone in the lower leg.
- Fibula (Lower Leg): Provides stability and muscle attachment sites for the lower leg.

- Tarsals/Metatarsals (Ankle/Foot): Support body weight and aid in walking/balance.

Joints and other related key terms:

Joints are the structural junctions where two or more bones meet, enabling body movement, support, and flexibility. With over 300 in the human body, they are categorized by mobility (fixed or movable) or structure (fibrous, cartilaginous, or synovial). They consist of cartilage, ligaments, tendons, and synovial fluid for lubrication.

Types of Joints (Structural Classification)

- Synovial Joints: Freely movable joints, characterized by a fluid-filled cavity (e.g., knee, shoulder).
- Cartilaginous Joints: Connected by cartilage; these offer slight movement, such as the vertebrae and pubic symphysis.
- Fibrous Joints: Immovable or fixed joints connected by dense connective tissue, such as sutures in the skull.

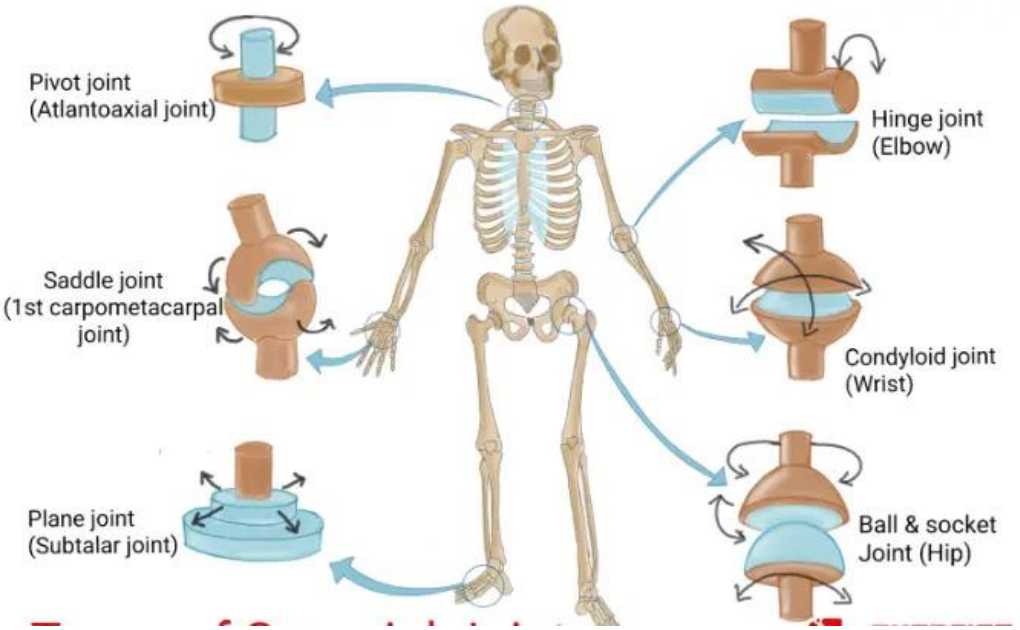
Types of Synovial Joint Motion

- Hinge Joints: Allow motion in one plane, like a door (e.g., elbow, knee).
- Ball and Socket Joints: Enable movement in multiple directions (e.g., shoulder, hip).
- Pivot Joints: Allow rotation around an axis (e.g., top of the neck).
- Saddle Joints: Allow back-and-forth/side-to-side movement (e.g., base of the thumb).
- Condyloid Joints: Allow movement without rotation (e.g., jaw, knuckles).
- Planar/Gliding Joints: Allow bones to glide past one another (e.g., wrist bones).

Key Components of Joints

- Cartilage: Tissue that covers bone surfaces, reducing friction.

- Ligaments: Tough, elastic bands that connect bones to other bones.



Structure of a bone:

A bone is a living structure made up of different parts that work together to provide strength, support, and flexibility. The outermost layer of the bone is called the periosteum. It is a thin covering that protects the bone and contains blood vessels and nerves.

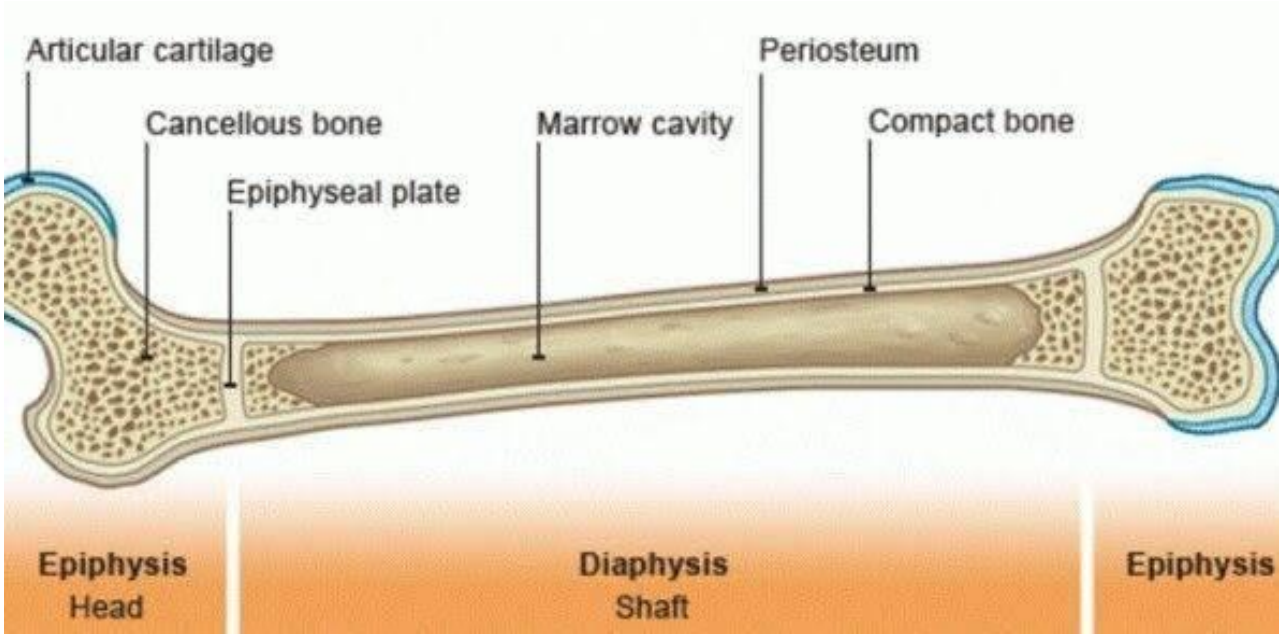
Below the periosteum is the compact bone, which is hard and dense. It gives strength to the bone and helps it bear weight. Inside this layer is the spongy bone, which is lighter and contains small spaces. These spaces make the bone less heavy and often contain bone marrow.

The bone marrow is a soft tissue present inside the bone. It produces blood cells and stores fat. In long bones, there is a hollow space called the medullary cavity, which contains bone marrow and helps reduce the weight of the bone.

The ends of a long bone are called the epiphysis, while the middle part is known as the diaphysis. The epiphysis

helps in forming joints, and the diaphysis provides strength and support.

At the ends of bones, there is a smooth layer called cartilage. It reduces friction and allows easy movement at joints.

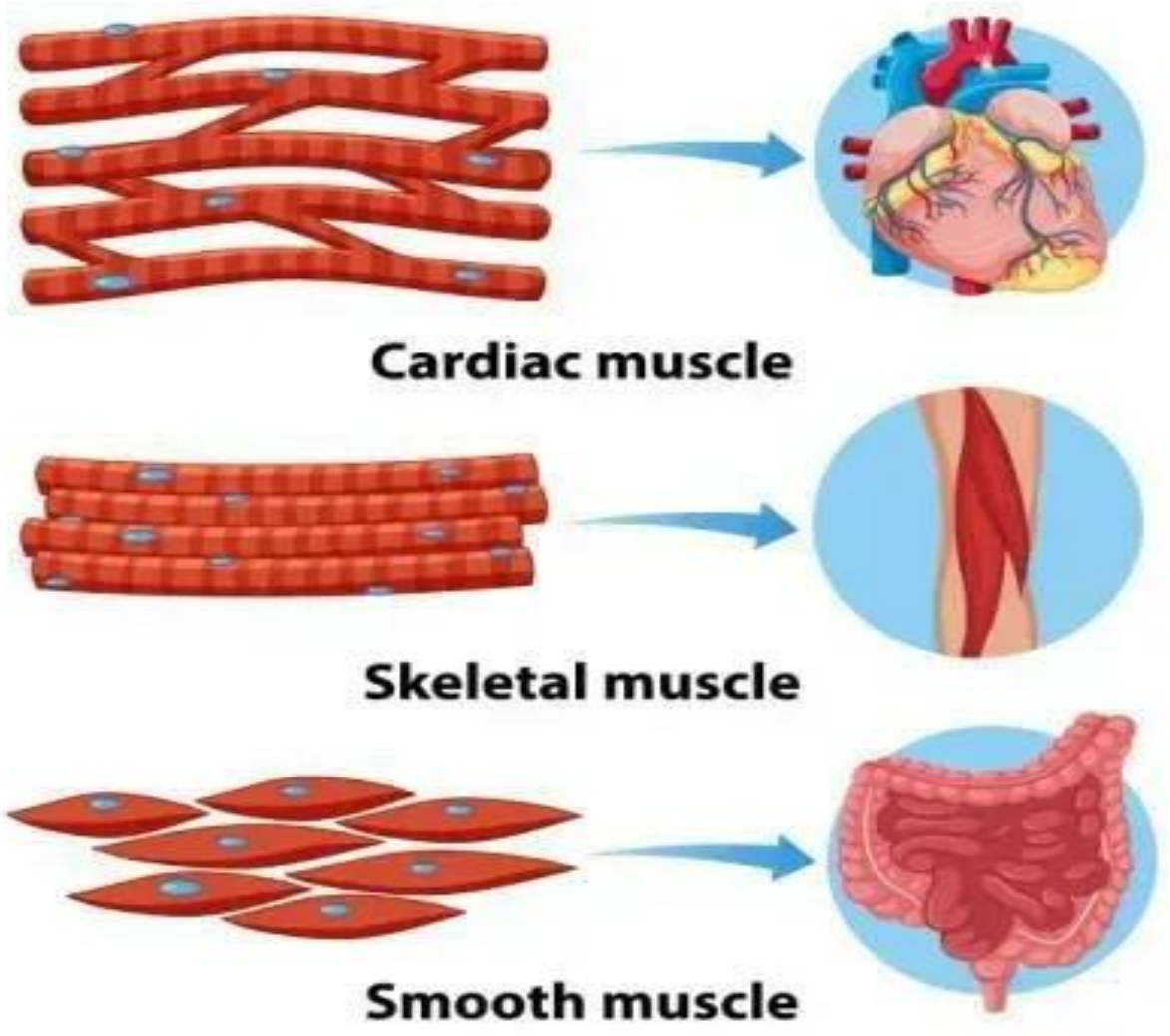


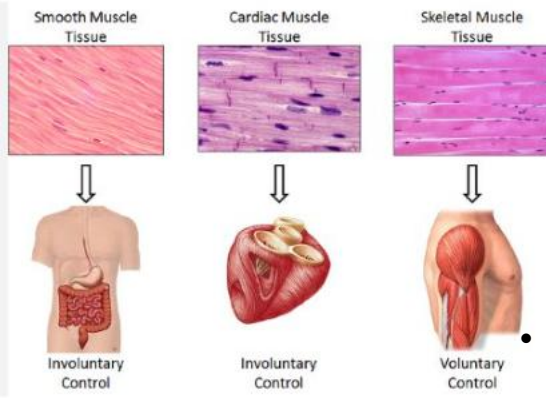
4. Muscular system:-

The muscular system, composed of over 600 muscles, enables movement, maintains posture, and circulates blood. It constitutes about 40% of body weight.

Types of Muscle Tissue:

- Skeletal Muscle: Attached to bones by tendons, these are voluntary muscles responsible for movement and posture.
- Cardiac Muscle: Found exclusively in the heart, this involuntary tissue contracts to pump blood.
- Smooth Muscle: Located in the walls of hollow organs (e.g., stomach, intestines, blood vessels), it controls involuntary movements like digestion and blood flow.



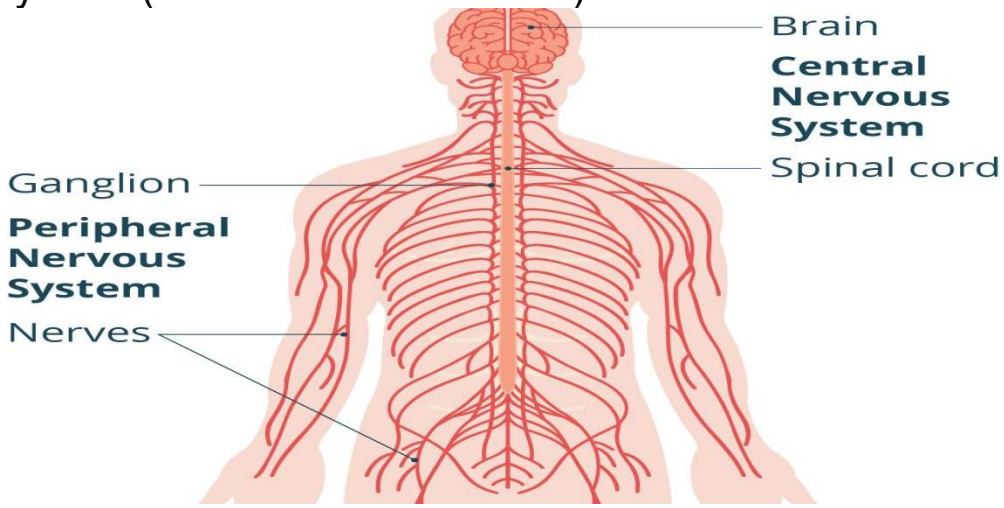


Functional Groups:
Muscles rarely act alone and are classified by their action:

- Prime Movers (Agonists): Primarily responsible for a specific movement.
- Antagonists: Oppose or resist a movement.
- Synergists: Aid prime movers, adding force or reducing unnecessary movement.
- Fixators: Stabilize a joint or bone.

5. Nervous System:-

The nervous system is the body's primary communication, control, and regulatory network, comprising the brain, spinal cord, and a vast nerve network. It manages everything from voluntary movements and thought to involuntary functions like breathing, digestion, and heart rate. The system consists of the central nervous system (CNS - brain/spinal cord) and the peripheral nervous system (PNS - all other nerves).



Key Components & Functions:

- Central Nervous System (CNS): Comprises the brain and spinal cord, acting as the main command center for processing information, managing thought, and storing memory.

Structure: Composed of the brain (cerebrum, cerebellum, brainstem) and the spinal cord, protected by the skull and vertebrae.

Function: Receives sensory input, analyzes data, and sends motor commands.

- Peripheral Nervous System (PNS): Consists of nerves branching from the brain and spinal cord to the rest of the body, allowing communication between the brain and limbs, organs, and sensory receptors.

Structure: Comprised of nerves and ganglia outside the CNS, including 12 pairs of cranial nerves and 31 pairs of spinal nerves.

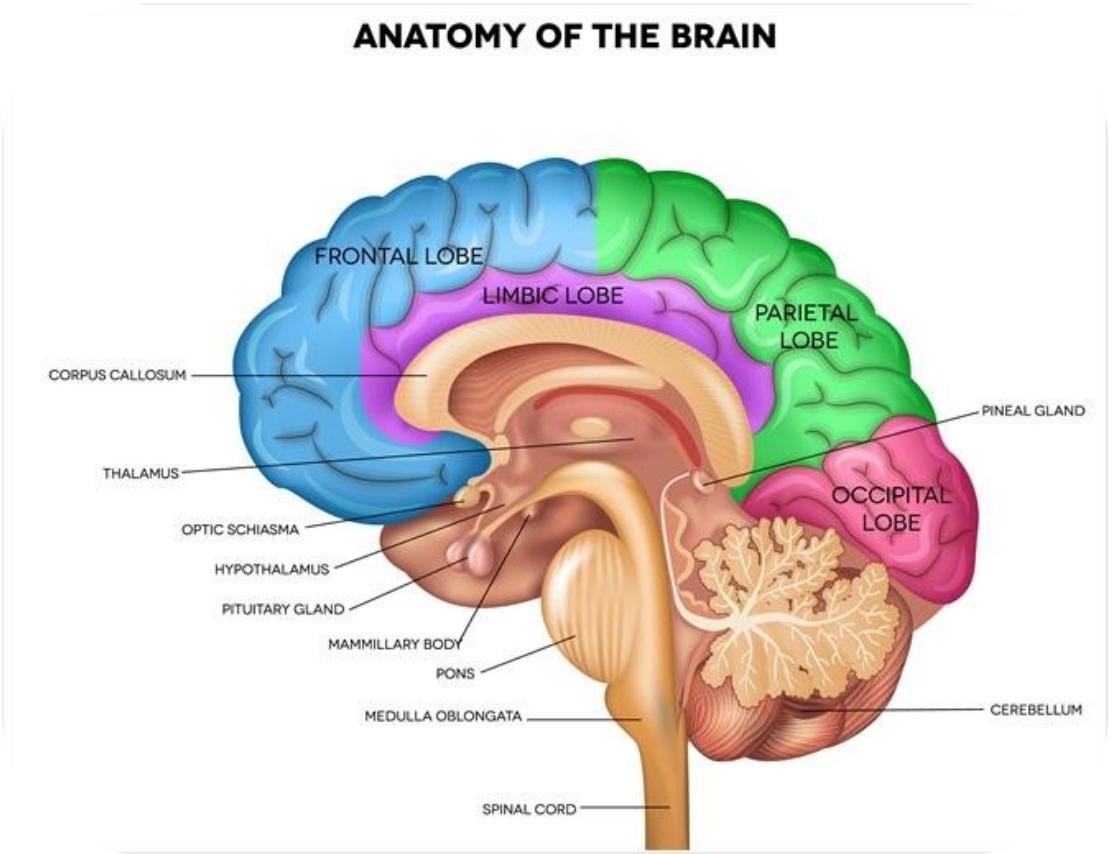
Somatic System: Controls voluntary movements of muscles.

Autonomic System: Regulates involuntary functions (heart rate, digestion) through sympathetic ("fight or flight") and parasympathetic ("rest and digest") branches.

Sensory & Motor Roles: Sends sensory information to the CNS(or afferent) and carries motor commands from the CNS to muscles and organs .

Neurons: Specialized cells (neurons) transmit electrical impulses (nerve impulses) throughout this network to send signals quickly.

Structure Of Brain:



1. Frontal lobe

Function: Thinking, decision-making, emotions, voluntary actions
If not working: Poor judgment, personality changes, difficulty in movement

2. Parietal lobe

Function: Sensation (touch, pain, temperature)
If not working: Loss of sensation, difficulty identifying objects by touch

3. Occipital lobe

Function: Vision
If not working: Vision defects or blindness

4. Limbic system (shown as limbic lobe)

Function: Emotions, memory, behavior
If not working: Memory loss, emotional imbalance

5. Corpus callosum

Function: Connects left & right hemispheres
If not working: Poor coordination between two brain halves

6. Thalamus

Function: Relay station for sensory signals
If not working: Sensory confusion, improper signal transmission

7. Hypothalamus

Function: Controls temperature, hunger, hormones
If not working: Problems in body temperature, hunger, hormonal imbalance

8. Pituitary gland

Function: Master gland (controls other glands)
If not working: Hormonal disorders, growth problems

9. Pineal gland

Function: Controls sleep cycle (melatonin)
If not working: Sleep disturbances

10. Optic chiasma

Function: Crossing of optic nerves (vision coordination)
If not working: Vision problems, loss of visual field

11. Mammillary body

Function: Memory processing
If not working: Memory loss

12. Pons

Function: Helps in breathing & communication between brain parts
If not working: Breathing irregularities, sleep problems

13. Medulla oblongata

Function: Controls heartbeat, breathing, reflexes
If not working: Life-threatening (breathing/heartbeat may stop)

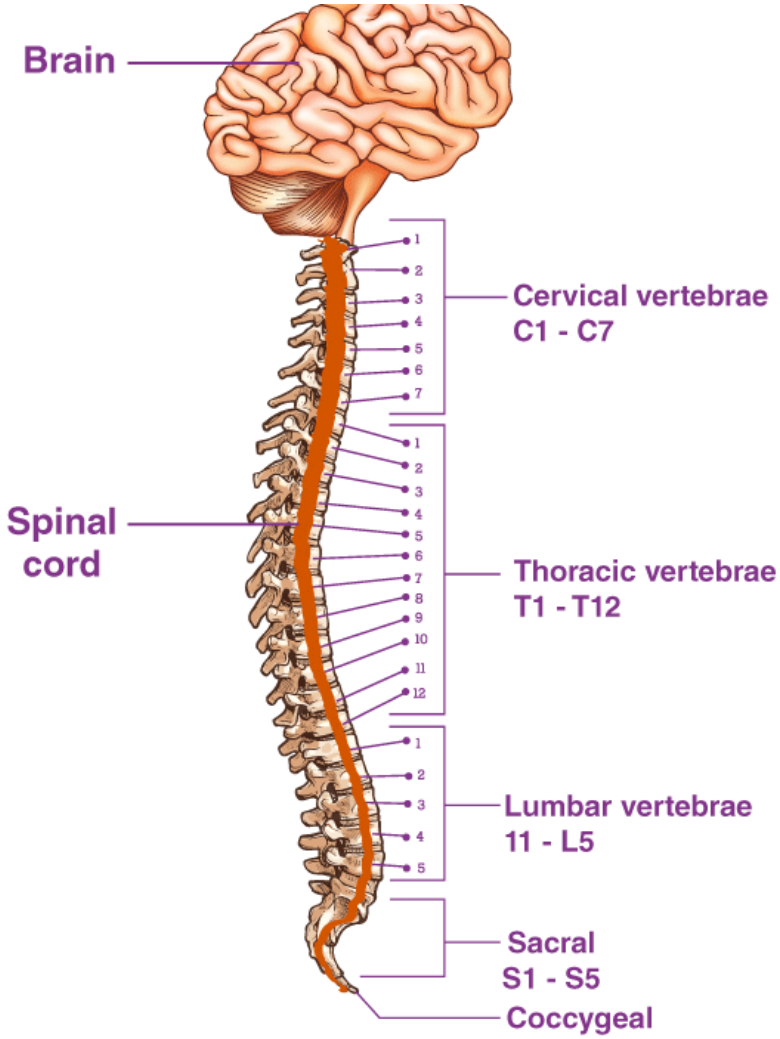
14. Cerebellum

Function: Balance & coordination
If not working: Loss of balance, shaky movements

15. Spinal cord

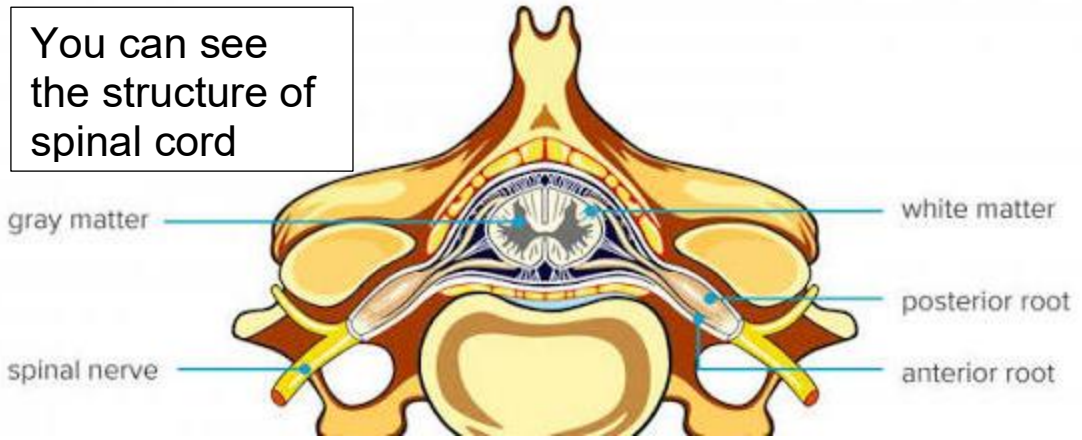
Function: Transmits signals between brain & body
If not working: Paralysis, loss of reflexes

Structure Of Spinal Cord:



The spinal cord is a 45 cm long, cylindrical bundle of nervous tissue extending from the brainstem to the lower back,protected by vertebrae and meninges. It transmits electrical signals between the brain and body, consisting of inner gray matter,outer white matter, and 31 pairs of nerves.

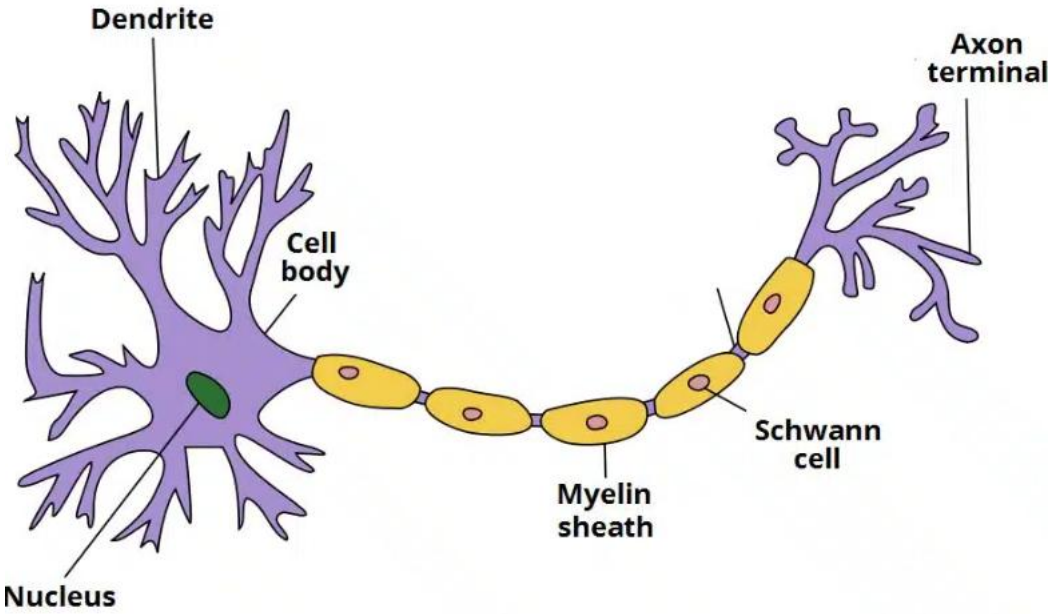
You can see the structure of spinal cord



Structure of a nerve:

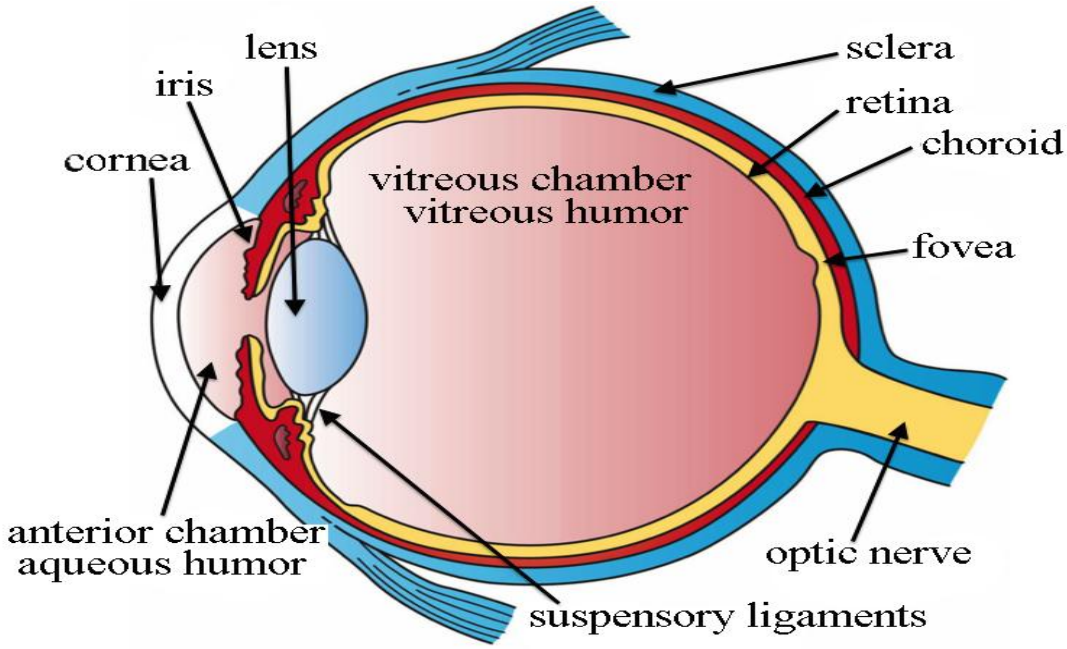
- Axons (Nerve Fibers): Long, thin extensions of neurons that carry electrical signals away from the cell body.

- Myelin Sheath: A fatty, insulating layer wrapped around axons (by Schwann cells in the PNS) that dramatically increases impulse speed,and CNS uses oligodendrocytes.
- Fascicles: Bundles of numerous nerve fibers (axons) grouped together.



These nerves transport messages to organs like:-eyes,ears and etc.

Structure Of Eyes:



The human eye is one of the most remarkable and delicate sense organs in the body. It allows us to see,

interpret, and understand the world around us by detecting light and converting it into signals that the brain can process.

Structure of the Eye

The eye is roughly spherical in shape and is protected by the skull. Its main parts include the cornea, iris, pupil, lens, retina, and optic nerve. The cornea is the transparent, curved front layer of the eye that allows light to enter and helps in focusing it. Behind the cornea lies the iris, the colored part of the eye that controls the size of the pupil. The pupil is the small opening in the center of the iris through which light enters the eye. The lens is a transparent and flexible structure that focuses light onto the retina and changes its shape to see objects clearly at different distances. The retina is a light-sensitive layer at the back of the eye that contains special cells called rods and cones. The optic nerve is responsible for carrying visual information from the retina to the brain.

How the Eye Works

When light from an object enters the eye, it first passes through the cornea and then through the pupil. The lens focuses this light onto the retina, forming an image that is actually inverted, or upside down. The retina then converts this image into electrical signals, which are sent to the brain through the optic nerve. The brain interprets these signals and allows us to see the object in the correct orientation.

Role of Rods and Cones

The retina contains two types of specialized cells known as rods and cones. Rods help us see in dim light and are responsible for night vision, while cones enable us to see colors and fine details, especially in bright light.

Care of the Eyes

Proper care of the eyes is essential to maintain good vision. It is important to avoid reading in dim light and to maintain a proper distance from screens and books. A healthy diet rich in Vitamin A, such as carrots and green vegetables, supports eye health. Additionally, one should avoid rubbing the eyes with dirty hands to prevent infections.

Importance of the Eye

The eye not only helps us see but also plays a major role in communication, expression, and learning. It connects us to our surroundings and enhances our understanding of the environment.

6. Digestive System:-

The digestive system is a complex, continuous tract—comprising the mouth, esophagus, stomach, small intestine, large intestine, and anus—that breaks down food into nutrients for energy, growth, and repair. Supported by the liver, pancreas, and gallbladder, it converts food into usable molecules, absorbing them into the bloodstream while eliminating waste.

Key Components and Functions

- **Mouth & Esophagus:** Mechanical digestion begins with chewing, while saliva (amylase) initiates chemical digestion. Food is pushed down the esophagus by peristalsis.
- **Stomach:** Churns food, using acid and enzymes (pepsin) to break down proteins into a thick liquid called chyme.
- **Small Intestine:** The primary site of digestion and absorption. The pancreas secretes enzymes, and the liver/gallbladder provides bile to digest fats, carbohydrates, and proteins. Nutrients are absorbed into the blood through villi.
- **Large Intestine (Colon):** Absorbs water from remaining waste and turns it into solid stool.
- **Rectum & Anus:** Stores and eliminates fecal matter.

Accessory Organs (Digestive Aids)

- **Liver:** Produces bile, which helps digest fats.
- **Gallbladder:** Stores and concentrates bile.
- **Pancreas:** Produces digestive enzymes for fats, proteins, and carbohydrates.

Key Processes

The digestive system operates through six main processes: ingestion, propulsion (movement), mechanical breakdown, chemical digestion, absorption, and

defecation. It is regulated by both the nervous system and hormones.

7.Cardiovascular System:-

The cardiovascular system, also known as the circulatory system, is essential for transporting blood, nutrients, and oxygen throughout the body, while also removing waste products.

Components of the Cardiovascular System

is the system responsible for delivering blood to different parts of the body. It consists of the following

The heart: The heart is a muscular pump that forces blood around the body.

A closed system of blood vessels: Blood vessels include:

o Arteries: The arteries carry blood away from the heart.

o Veins: Veins are vessels that bring blood back to the heart.

o Capillaries: Capillaries are tiny vessels that branch off from arteries to deliver blood
to all body tissues.

There are two blood circulatory systems in the body. The systemic circulatory system is the main blood circulatory system that transports blood to the organs, tissues, and cells throughout the body.

Structure of the heart

The heart consists of four distinct chambers: two upper chambers called atria and two lower
chambers called ventricles.

A wall or "septum" separates the atria and ventricles.

Valves control the flow of blood within
the different chambers.

Blood follows the following path " through the heart:

1. Blood lacking oxygen returns from the body and enters the right atrium (upper right chamber) via the Inferlor vena cava and superlor vena cava veins.
2. Blood flows through the tricuspid valve and enters the right ventricle (lower right chamber).
3. The right ventricle pumps blood through the pulmonary valve and out of the heart via the main pulmonary artery.

4. The blood then flows through the left and right pulmonary arterles Into the lungs. Here,the process of breathing draws oxygen Into the blood and removes carbon dioxide. As a result, the blood is now rich In oxygen.
5. The blood returns to the heart and flows Into the left atrium (upper left chamber) via four pulmonary veins.
6. Blood flows through the mitral valve and enters the left ventricle (lower left chamber).
7. The left ventricle pumps the blood through the aortic valve Into a large artery called the aorta. This artery delivers blood to the rest of the body.

The importance of the heart

The heart pumps blood through closed vessels to every tissue within the body. The blood nutrients and oxygen to all cells In the body.

Without blood, the cells and tissues would not function at their total capacity and would begin to malfunction and die.

What is the cardiac cycle?The cardiac cycle consists of two phases: diastole and systole.

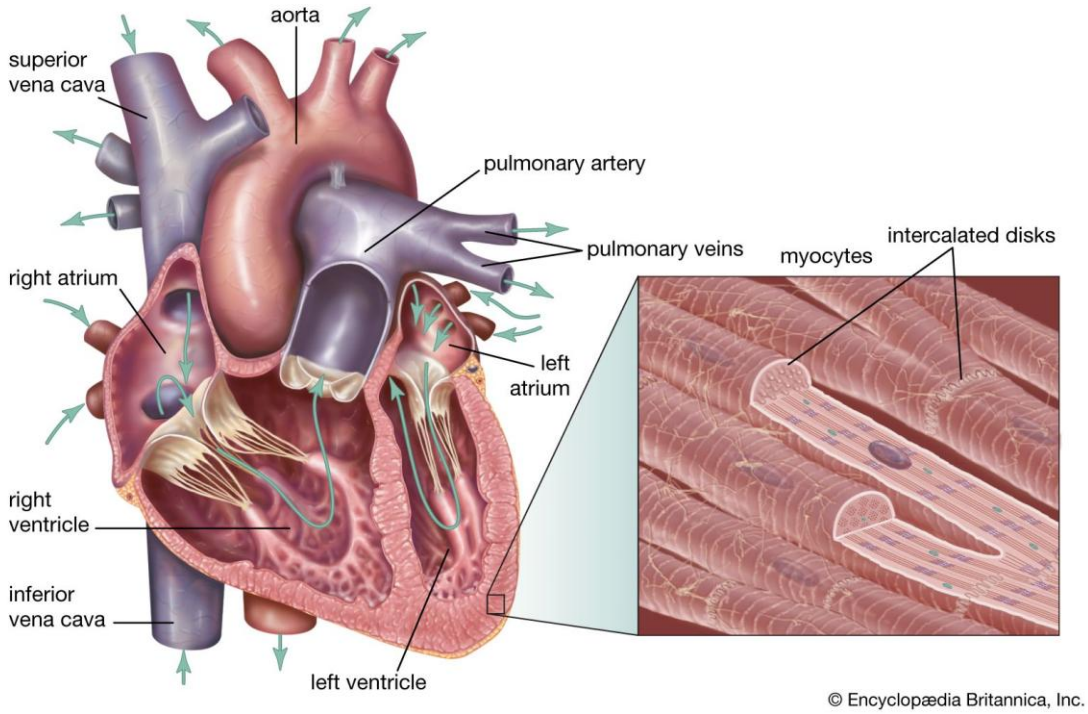
The first phase is diastole, in which the ventricles fill with blood. It begins when the aortic or pulmonary valve closes and ends when the mitral or tricuspid valve closes.

During diastole, blood vessels return blood to the heart in preparation for the next contraction
of the ventricles.

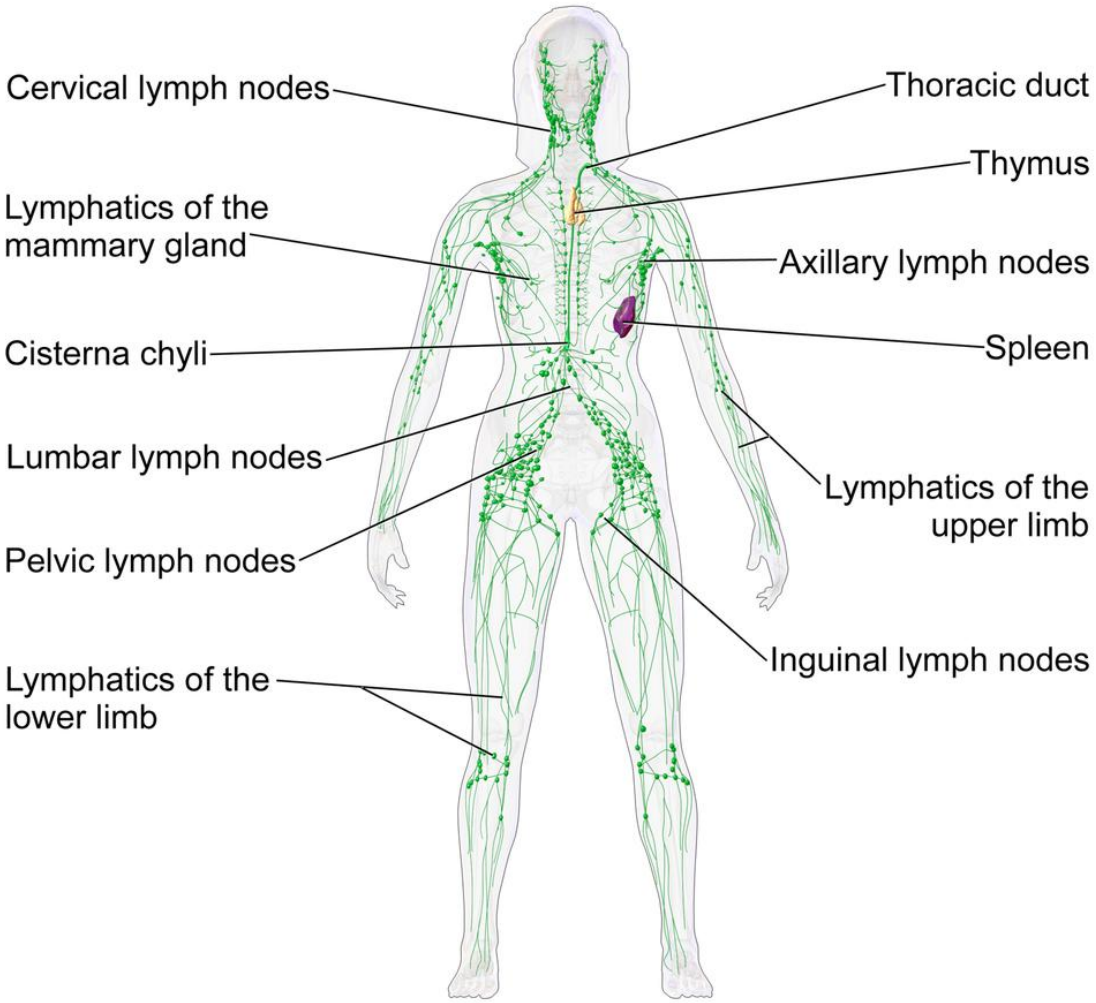
The second phase is systole, in which the ventricles contract and eject blood. It begins when
the mitral or tricuspid valve closes and ends when the aortic or pulmonary valve closes.

The pressure inside the ventricles becomes greater than the pressure inside adjacent blood

vessels, thereby forcing the blood from the ventricles to the vessels.



8.Lymphatic System:-



The **lymphatic system**, or **lymphoid system**, is an organ system in vertebrates that is part of the immune system and complementary to the circulatory system. It consists of a large network of lymphatic vessels, lymph nodes, lymphoid organs, lymphatic tissue and lymph.[1][2] The Latin word for lymph, *lympha*, refers to the deity of fresh water, "Lympha".[3]

Unlike the circulatory system, which is a closed system, the lymphatic system is open.[4][5] Lymph originates in the interstitial fluid that leaks from blood in the circulatory system into the tissues of the body. This fluid carries nutrients to the cells and collects waste products, bacteria, and damaged cells, before draining into the lymphatic vessels as lymph. The other main function is that of

immune defense. Lymph is very similar to blood plasma, in that it contains waste products and cellular debris, together with bacteria and proteins. The cells of the lymph are mostly lymphocytes. Associated lymphoid organs are composed of lymphoid tissue, and are the sites either of lymphocyte production or of lymphocyte activation. These include the lymph nodes (where the highest lymphocyte concentration is found), the spleen, the thymus, and the tonsils.

The lymphatic system was first described in the 17th century independently by Olaus Rudbeck and Thomas Bartholin.[11]

Structure

Anatomy of the lymphatic system showing primary and secondary lymphoid organs

The lymphatic system consists of a conducting network of lymphatic vessels, lymphoid organs, lymphoid tissues, and the circulating lymph.[1]

Primary lymphoid organs

The primary (or central) lymphoid organs, including the thymus, bone marrow, fetal liver, and yolk sac, are responsible for generating lymphocytes from immature progenitor cells in the absence of antigens.[12] The thymus and the bone marrow constitute the primary lymphoid organs involved in the production and early clonal selection of lymphocyte tissues.

Bird species' primary lymphoid organs include the bone marrow, thymus, bursa of Fabricius, and yolk sac.[13]

Red bone marrow

Bone marrow- specifically red bone marrow-[14] is responsible for both the creation of T cell precursors and the production and maturation of B cells, which are known as lymphocytes, important cell types of the immune

system. From the red bone marrow, B cells immediately join the circulatory system and travel to secondary lymphoid organs in search of pathogens. T cells, on the other hand, travel from the bone marrow to the thymus, where they undergo a multistage process to develop immunocompetency.

Thymus

The thymus increases in size from birth in response to postnatal antigen stimulation. It is most active during the neonatal and pre-adolescent periods. The thymus is located between the inferior neck and the superior thorax. During adolescence, the thymus begins to atrophy and regress, with adipose tissue mostly replacing the thymic stroma. However, residual T cell lymphopoiesis continues throughout adulthood, providing some immune response. The thymus is where the T lymphocytes mature and become immunocompetent.

Secondary lymphoid organs

The secondary (or peripheral) lymphoid organs, which include lymph nodes and the spleen, maintain mature naive lymphocytes and initiate an adaptive immune response.[16] The secondary lymphoid organs are the sites of lymphocyte activation by antigens.[17] Activation leads to clonal selection and affinity maturation. Mature lymphocytes recirculate between the blood and the secondary lymphoid organs until they encounter their specific antigen.

Spleen

The main functions of the spleen are:

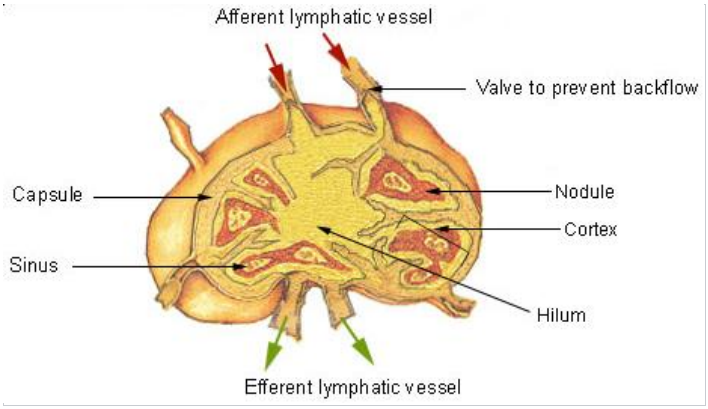
1. to produce immune cells to fight antigens,
2. to remove particulate matter and aged blood cells, mainly red blood cells, and
3. to produce blood cells during fetal life.

The spleen synthesizes antibodies in its white pulp and removes antibody-coated bacteria and antibody-coated blood cells by way of blood and lymph node circulation. The white pulp of the spleen provides immune function due to the lymphocytes housed there. The spleen also consists of red pulp, which is responsible for getting rid of aged red blood cells and pathogens. This is carried out by macrophages present in the red pulp. A study published in 2009 using mice found that the spleen contains, in its reserve, half of the body's monocytes within the red pulp.[18] These monocytes, upon moving to injured tissue (e.g., the heart), turn into dendritic cells and macrophages while promoting tissue healing.[18][19][20] The spleen is a center of activity of the mononuclear phagocyte system. It can be considered analogous to a large lymph node, as its absence causes a predisposition to certain infections. Notably, the spleen is essential for a multitude of functions. The spleen removes pathogens and old erythrocytes from the blood (red pulp) and produces lymphocytes for immune response (white pulp). The spleen is also responsible for recycling some erythrocyte components and discarding others. For example, hemoglobin is broken down into amino acids, which are reused.

Research on bony fish has shown that a high concentration of T cells is found in the spleen's white pulp.[15]

Like the thymus, the spleen has only efferent lymphatic vessels. Both the short gastric arteries and the splenic artery supply it with blood.[21] The germinal centers are supplied by arterioles called *penicilliary radicles*.[22]

Lymph nodes



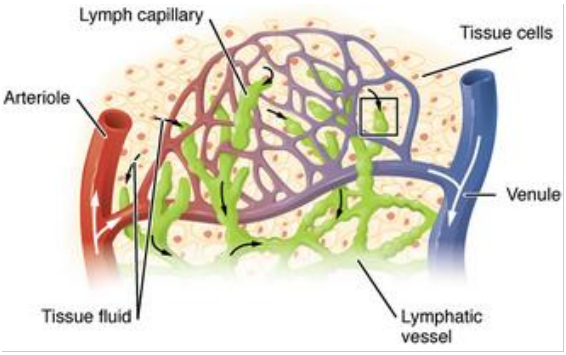
A lymph node showing afferent and efferent lymphatic vessels.

A lymph node is an organized collection of lymphoid tissue through which the lymph passes on its way back to the blood. Lymph nodes are located at intervals along the lymphatic system. Several afferent lymph vessels bring in lymph, which percolates through the substance of the lymph node and is then drained out by an efferent lymph vessel. The substance of a lymph node consists of lymphoid follicles in an outer portion called the cortex. The inner portion of the node is called the medulla, which is surrounded by the cortex on all sides except for a portion known as the hilum. The hilum presents as a depression on the surface of the lymph node, causing the otherwise spherical lymph node to be bean-shaped or ovoid. The efferent lymph vessel directly emerges from the lymph node at the hilum. The arteries and veins supplying the lymph node with blood enter and exit through the hilum. The region of the lymph node called the paracortex immediately surrounds the medulla. A lymph follicle is a dense collection of lymphocytes, the number, size, and configuration of which change in accordance with the functional state of the lymph node. For example, the follicles expand significantly when encountering a foreign antigen. The selection of B cells (also known as B lymphocytes) occurs in the germinal centre of the lymph nodes.

Tertiary lymphoid organs

Tertiary lymphoid organs (TLOs) are abnormal lymph node-like structures that form in peripheral tissues at sites of chronic inflammation, such as chronic infection, transplanted organs undergoing graft rejection, some cancers, and autoimmune and autoimmune-related diseases

Lymphatic vessels



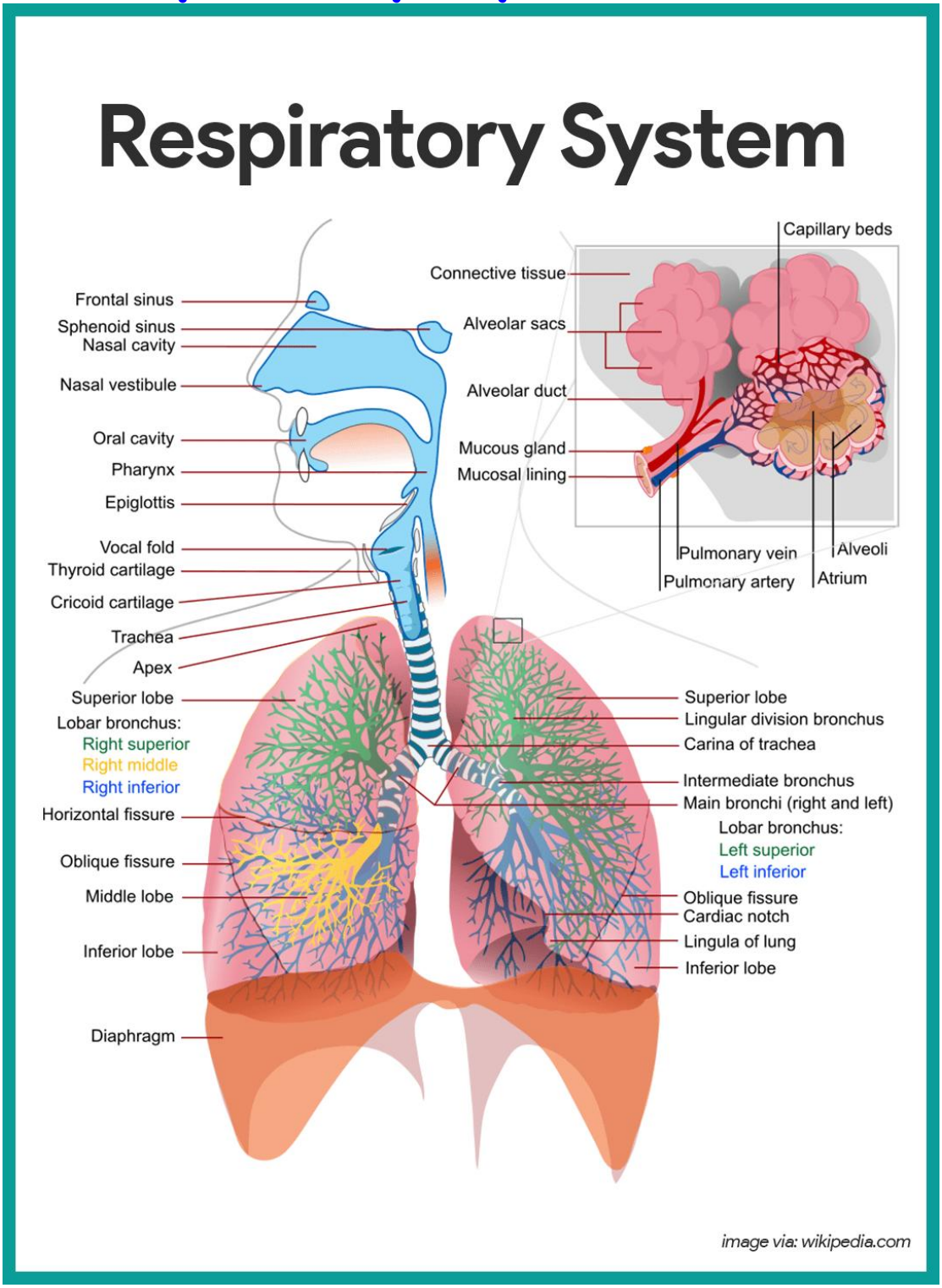
Lymph capillaries in the tissue spaces

The lymphatic vessels, also called lymph vessels, are thin-walled vessels that conduct lymph between different parts of the body.[41] They include the tubular vessels of the lymph capillaries, and the larger collecting vessels – the right lymphatic duct and the thoracic duct (the left lymphatic duct). Lymph capillaries are primarily responsible for the absorption of interstitial fluid from the tissues. Lymph vessels propel the absorbed fluid forward into the larger collecting ducts, where it ultimately returns to the bloodstream via one of the subclavian veins.

The lymphatic system has multiple interrelated functions:

- It is responsible for the removal of interstitial fluid from tissues
- It absorbs and transports fatty acids and fats as chyle from the digestive system
- It transports white blood cells to and from the lymph nodes into the bones
- The lymph transports antigen-presenting cells, such as dendritic cells, to the lymph nodes where an immune response is stimulated.

9.Respiratory System:-



The respiratory system is essential for breathing, facilitating gas exchange, and maintaining the body's oxygen and carbon dioxide levels.

Nose and Sinuses

Frontal Sinus

Air-filled space in the forehead that helps warm air and lighten the skull.

If affected: Sinus infection can cause forehead pain and headache.

Sphenoid Sinus

Sinus located deep behind the nose.

If affected: Deep headaches and facial pain may occur.

Nasal Cavity

Filters, warms, and moistens incoming air.

If affected: Breathing becomes difficult and infections may increase.

Nasal Vestibule

Front part of the nose containing hairs that trap dust.

If affected: More dust and germs enter the respiratory tract.

Mouth and Throat

Oral Cavity

The mouth; acts as an alternate air passage.

If affected: Speaking, eating, and breathing may be affected.

Pharynx

The throat; passage for food and air.

If affected: Swallowing and breathing problems can occur.

Epiglottis

A flap that closes the windpipe during swallowing.

If affected: Food may enter the lungs, causing choking.

Voice Box (Larynx)

Vocal Fold (Vocal Cords)

Produce sound when air passes through them.

If affected: Hoarse voice or loss of voice.

Thyroid Cartilage

Protects the vocal cords (forms Adam's apple).

If affected: Voice box becomes vulnerable to injury.

Cricoid Cartilage

Ring-shaped cartilage supporting the airway.

If affected: Airway may become unstable.

Windpipe

Trachea

Tube carrying air to the lungs.

If affected: Severe breathing difficulty.

Carina of Trachea

Point where the trachea splits into two bronchi.

If affected: Persistent coughing and breathing issues.

🫁 Lungs

Apex

Top portion of each lung.

If affected: Lung diseases may reduce breathing efficiency.

Superior Lobe

Upper section of the lung.

If affected: Reduced oxygen exchange.

Middle Lobe (Right Lung Only)

Middle section of the right lung.

If affected: Breathing capacity decreases.

Inferior Lobe

Lower section of the lung.

If affected: Oxygen intake becomes less effective.

Lingula of Lung

Small tongue-like part of the left lung.

If affected: Usually minor effect unless diseased.

Cardiac Notch

Indentation in the left lung for the heart.

If affected: It is a normal structure and not usually a disease site.

Airways Inside the Lungs

Main Bronchi (Right and Left)

Carry air from trachea into each lung.

If affected: Air cannot reach lungs properly.

Lobar Bronchus

Branches supplying lung lobes.

Right Superior Bronchus

Supplies upper right lobe.

Right Middle Bronchus

Supplies middle right lobe.

Right Inferior Bronchus

Supplies lower right lobe.

Left Superior Bronchus

Supplies upper left lobe.

Left Inferior Bronchus

Supplies lower left lobe.

If any bronchus is blocked: The supplied part of the lung receives little or no air.

Intermediate Bronchus

Branch between main bronchus and smaller bronchi.

If affected: Airflow to parts of the right lung decreases.

Lung Divisions

Horizontal Fissure

Separates upper and middle lobes of the right lung.

Oblique Fissure

Separates lung lobes.

If affected: Usually no major issue unless injured.

Tiny Air Sacs (Most Important for Gas Exchange)

Alveolar Duct

Tiny passage leading to alveolar sacs.

If affected: Less air reaches alveoli.

Alveolar Sacs

Clusters of tiny air sacs.

If affected: Oxygen absorption decreases.

Alveoli

Microscopic air sacs where oxygen enters blood and carbon dioxide leaves.

If damaged (like in smoking):

Shortness of breath

Less oxygen in blood

Diseases such as emphysema

Atrium (of Alveolar Sac)

Small central space connecting alveoli.

If affected: Air distribution becomes less efficient.

🩸 Blood Supply Around Alveoli

Capillary Beds

Tiny blood vessels surrounding alveoli.

Function: Exchange oxygen and carbon dioxide.

If affected: Blood cannot receive enough oxygen.

Pulmonary Artery

Carries oxygen-poor blood from the heart to the lungs.

If blocked: Dangerous reduction in oxygenation.

Pulmonary Vein

Carries oxygen-rich blood from lungs to heart.

If affected: Oxygen delivery to the body decreases.

Supporting Structures

Connective Tissue

Supports and holds lung structures together.

If damaged: Lungs lose elasticity.

Mucosal Lining

Moist lining protecting airways.

If damaged: Irritation and infection become more likely.

Mucous Gland

Produces mucus to trap dust and germs.

If affected: Airways become dry or unable to trap particles properly.

🫁 Diaphragm (VERY IMPORTANT)

Diaphragm

Main muscle used for breathing.

When you inhale: It contracts and moves downward, making space for the lungs.

When you exhale: It relaxes and moves upward.

If paralyzed: Breathing becomes extremely difficult and may require medical support.

Easy Breathing Path to Remember

Nose/Mouth → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Alveolar Ducts → Alveolar Sacs → Alveoli → Blood

That's the complete journey of air through the respiratory system shown in your diagram. 🫁✨

10.Urinary System:-

The urinary system removes waste products from the blood and maintains the body's water, salt, and chemical balance.

Parts of the Urinary System

Kidneys
Two bean-shaped organs located on either side of the backbone. They filter blood, remove wastes, regulate water content, and help maintain blood pressure.

Renal Artery
Brings blood containing wastes and excess substances to the kidneys for filtration.

Renal Vein
Carries filtered blood away from the kidneys and back into circulation.

Nephron
The structural and functional unit of the kidney. Each kidney contains about one million nephrons.

Glomerulus
A network of capillaries where blood filtration begins.

Bowman's Capsule
A cup-shaped structure that surrounds the glomerulus and collects the filtered fluid.

Proximal Convoluted Tubule (PCT)
Reabsorbs most of the water, glucose, amino acids, and salts needed by the body.

Loop of Henle
Helps conserve water and concentrates urine.

Distal Convoluted Tubule (DCT)
Further regulates salt, water, and pH balance.

Collecting Duct
Receives urine from nephrons and carries it toward the renal pelvis.

Renal Pelvis
A funnel-shaped cavity in the kidney that collects urine before it enters the ureter.

Ureters
Two tubes that transport urine from the kidneys to the urinary bladder.

Urinary Bladder
A muscular sac that stores urine until it is expelled.

Urethra
The tube through which urine leaves the body.

Formation of Urine

1. **Filtration** – Blood is filtered in the glomerulus.
2. **Reabsorption** – Useful substances are taken back into the blood.
3. **Secretion** – Additional wastes are added to the filtrate.
4. **Excretion** – Urine leaves the body through the urethra.

Path of Urine

Blood → Kidney → Nephron → Collecting Duct → Renal Pelvis → Ureter → Urinary Bladder → Urethra → Outside the Body

Main Functions

- Removal of nitrogenous wastes such as urea

- Regulation of water balance
- Regulation of salt concentration
- Maintenance of pH balance
- Regulation of blood pressure
- Production of certain hormones

THE HUMAN BODY:
From Cells to Body Systems

by Genius Jigisha

This is not just a book, it is a journey of curiosity and knowledge. Every page you turn brings you closer to seeing the world not just as it is, but as it can be understood. Designed for thinkers, learners, and future innovators, this book transforms simple concepts into powerful understanding.

About the Author

Genius Jigisha is an emerging author with a strong interest in learning and a thoughtful approach to understanding academic concepts. Through her work, she aims to present knowledge in a clear and engaging manner, reflecting her curiosity and dedication to continuous growth. She also shares her ideas and learning journey through her official YouTube channel,*Genius Jigisha*.

© 2026 Genius Jigisha

All rights reserved.